exposed to the moist southerly winds, but it has two advantages over the stations in the plains, viz., that there are nearly 7,000 feet less atmosphere above it, and it is free from the dust haze, so prevalent on the plains, which perhaps more than water vapour (if not thickly condensed) stops a large part of the solar radiation. On clear days and in intervals between the clouds, the sun's heat is sometimes very intense. The table that follows has been compiled in a different manner from that which I communicated a fortnight since. Instead of picking out days with little or no cloud (which are sure enough during the greater part of the year), I have taken the three highest recorded sun-temperatures in each half-month, and from these have deducted the maximum air-temperatures recorded on the same days; the mean of the six observations being taken to represent the month. The same instrument has been in use since the observations were commenced in April 1870. I must leave it to meteorologists at home to compare these temperatures with the recorded sun-spot areas, which I am unable to ascertain. But the maximum radiation temperature evidently falls in 1871, the year of maximum spots, and the increase on that of the imperfect year 1870, and the fall in the subsequent years, at least up to the end of 1874, are very marked.

Mean differences of the three highest solar temperatures in each half-month and the corresponding maximum air temperatures at Darjiling.

	1870.	1871.	1872.	1873.	1874.	1875.
January	—	57·8	67·7	59·2	57·8	62·3
February	—	62·2	62·8	62·3	56·5	60·3
March	—	63·3	63·5	62	58·2	57·8
April	—	64·2	63·2	62·8	55·7	60·2
May	62·2	67·8	66·8	63·8	57·8	—
June	67	68	67·3	62·5	59·2	—
July	63·3	66·2	65·7	60·8	56·3	—
August	70·8	65·7	66·8	60	57·8	—
September	71·5	69·3	63·7	62·3	59·3	—
October	65·5	68·2	70	63·3	60·8	—
November	62·5	67·3	62·5	57·3	63·3	—
December	59	66·3	59	53·8	60·5	—
Yearly means	—	65·5	64·9	60·8	58·6	—

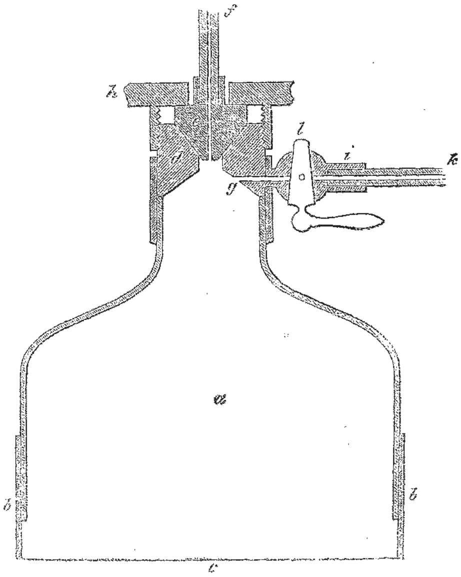
In my former note I adverted to Prof. Köppen's results on the variation of the temperature of the lower atmosphere in the tropics, which he showed to be inversely as the number of the sun-spots or nearly so, from 1820 to 1858. On thinking the matter over, this result, however anomalous at first sight, appears to me really only in conformity with what might be expected when taken in connection with the facts of the rainfall. Since three-fourths of the earth's surface are covered with water, the chief effect of increased radiation must necessarily be to increase the evaporation, and therefore the cloud and rainfall. The former of these will intercept a larger proportion of the solar heat and prevent its reaching the ground; while the latter, by its evaporation from the land surface, will still further reduce the temperature. The annual curves of temperature at the Bengal stations show most strikingly how the temperature falls with cloud and rain. A single heavy storm without any change in the prevalent wind direction reduces the temperature by several degrees for two or three days after the fall; and the same fact is illustrated in the mean annual curve, which falls considerably on the setting in of the rains, while there is generally a slight rise in September when the rains draw to a close. It follows, then, that the whole increase of the sun's heat and something more, in the tropics, is absorbed in evaporation and by the upper strata of the atmosphere, thus affording a confirmation of the speculation of (I think) Sir John Herschel, that the inferior planets (if partly covered by water) may enjoy an equable moderate temperature fitted for the existence of such terrestrial organisms as can thrive under a sombre sky.

June 7 H. F. BLANFORD

SCIENCE IN GERMANY

(*From a German Correspondent.*)

BUNSEN'S ice-calorimeter was used lately for a very interesting experiment by Messrs. Röntgen and Exner, who tried to determine the intensity of the radiation of the sun by means of an apparatus constructed on the principle of that calorimeter. The apparatus consists of a glass bell *a* of 75 mm. height. This is fastened into a brass hoop *b*, which is closed below by a plate of wrought silver of $\frac{1}{4}$ mm. thickness, and 106 mm. diameter. The neck of the bell bears a massive brass top *d*, which is cut conically above and below, and has a central opening of 6 mm. diameter. Into the exterior groove a massive brass cone *e* fits water-tight, having also the central boring, into which a little glass tube is fastened. By a screw *h* in the circumference, the cone *e* can be firmly pressed against the brass piece *d*, while the tube *f* communicates with the interior of the bell *a*. A second communication between the interior of the bell and the outside is obtained by the boring at *g* and the metal-tube *i*, with stopcock *l*.



When the apparatus is to be used as a pyrheliometer, the bell is filled with well-boiled distilled water, and the whole is frozen like one of Bunsen's calorimeters. To the tube *f* a long glass tube of perfect calibre and with millimetre divisions is fastened by means of a piece of india-rubber tubing; to the end *k* of the brass tube with stopcock an indiarubber ball filled with well-boiled water is then fastened, the stopcock opened, and while the apparatus is held vertically, all air which may still be contained in the bell is removed from it through the cone *e*, the tube *f*, and the divided tube, so that the latter is filled with water up to its end. Then the stopcock *l* is closed. If beforehand the silver plate has been carefully covered with soot, the apparatus is ready for use. It is directed towards the sun just like Pouillet's pyrheliometer, so that the sun's rays fall vertically upon the blackened plate. The divided tube is then supported as much as possible in a horizontal position, and the progress of the column of water in the same is observed with a second clock from minute to minute. This progress of the

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column of water would indicate directly the intensity of the radiation of the sun in calories if the ice did not also partly melt in consequence of the surrounding warm air. In order to eliminate this influence, the progress of the column of water must be observed before and after the actual experiment, and during these observations the sun's rays must be shut out from the apparatus by a screen. The difference of the readings with and without the sun's rays will then indicate the density of the latter. But this method has a drawback. It was found that with experiments which were made in quick succession, when the apparatus was exposed to the sun's rays, that the first results were always a little larger than the following ones, and that only after some time had elapsed did the results show a constant value. The reason of this is doubtless the formation of a stagnant layer of water in the apparatus below the blackened plate, and this layer must first reach a stationary position before anything like regularity is obtained in the results.

With regard to the general results of these experiments, which were made by Messrs. Röntgen and Exner on the platform of Strassburg Cathedral, the absolute values of the intensity of the radiation of the sun are considerably larger than those found by Pouillet. If Pouillet's values are reduced to the same measures and units, which form the basis of the values obtained by Röntgen and Exner, we find, for instance, for the month of June and the sun's elevation 12h. the value 1·140, while the latter observers still obtained 1·226 for an elevation of 12h. 15m. Further, we must remark that the values obtained by Röntgen and Exner are decidedly too small (the observations record the progress of the column of water after the stationary condition of the stagnant layer of water), and that according to a rough guess they should be at least 20 per cent. to 25 per cent. larger; thus it is certain that Pouillet's values must be looked upon as *considerably too small.*

*FERTILISATION OF FLOWERS BY INSECTS**

XI.

Adaptation of Flowers to Lepidoptera—Hesperis tristis.

LEPIDOPTERA are distinguished among all insects that visit flowers by their slender proboscis. Hence, in order to make their honey exclusively accessible to these insects, flowers have only to narrow the entrance to their nectaries to such a degree that no other proboscis but that of Lepidopterous insects is able to enter. This adaptation to butterflies by narrowing the entrance of the nectary in different families of plants has been arrived at in very different ways. In flowers with a tubular corolla (*Primula villosa*, *Daphne striata*, NATURE, vol. xi. p. 110, Figs. 43-47) the corolla-tube has narrowed; in flowers with a honey-secreting spur (*Gymnadenia*, *Nigritella*, NATURE, vol. xi. p. 170, Figs. 58-62) the entrance of the spur has been constricted; in the labiate flowers of *Rhinanthus alpinus* (NATURE, vol. xi. p. 111, Figs. 51-56) the large entrance of the flower is blocked up by the margins of the upper lip lying close together, and only a small opening in its rostrate projection has been left open; in the quite open flowers of *Lilium Martagon* (NATURE, vol. xii. p. 50) the honey-secreting furrow at the base of the sepals and petals has been converted into a narrow channel by a coating of glandular hairs. *Hesperis tristis*, belonging to the family of Cruciferæ, which are generally visited for honey by Apidæ, Syrphidæ, Muscidæ, and various other insects, has excluded from its honey all visitors except Lepidoptera, by simply lengthening its sepals and the basal portion of its petals and laying them close together. The sepals, indeed, as is shown by Fig. 65, are elongated to 11-15 mm., and whilst diverging and presenting open slits in their basal portion, are convergent and connate towards their tips. By this coalescence of the sepals the entrance of the flower is so constricted as to be almost completely filled up by the four longer anthers (*a*, Figs. 68, 69). At first, when the

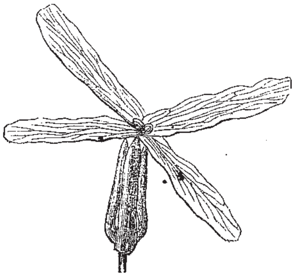

FIG. 65.—Flower of *Hesperis tristis* (natural size).

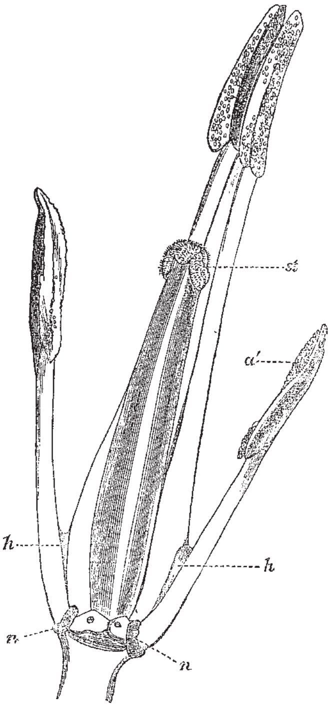

FIG. 66.

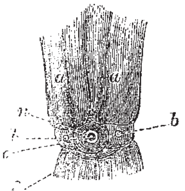

FIG. 67.

FIG. 66.—The same after the sepals, the petals, and two of the four longer anthers have been removed. *n*, nectary; *h*, honey; *a'*, shorter anther; *st*, stigma.

FIG. 67.—Situation of the nectary. *a a*, longer filaments; *o*, point of insertion of one of the shorter filaments; *b b*, points of insertion of the two adjacent petals; *d*, insertion of the adjacent sepal; *n*, nectary.

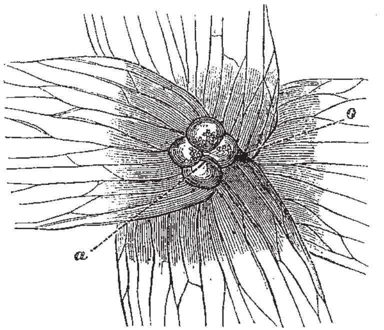

FIG. 68.—The centre of the flower at its first period seen from above. *a*, longer anthers; *o*, openings.

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* Continued from p. 50.

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